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TLND Correction Factor Evaluation using the ROSPEC

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Background

- On June 8, 2007 10CFR835 was amended to reflect recommendations given in ICRP 60
  - Updated organ/tissue weighting factors
  - Updated internal dosimetric models
  - Changed terminology
  - Updated Appendix A, C, and E
  - Introduced radiation weighting factors, operational, and protection quantities
  - Q(L)-L relationship was revised

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Background

- *Protection quantities* – Regulatory dose limits
  - Effective dose (E)
  - Equivalent dose (H_T)
- *Operational quantities* - Measureable quantities used to ensure compliance with dose limits
  - Personal dose equivalent $H_p(10)$
  - Ambient dose equivalent H*(10)
  - Directional dose equivalent H'(10, Ω)

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All Radiation Types are not Equal!

- Some types of radiation are more damaging per unit absorbed dose than others
  - This is due to Linear Energy Transfer (LET)
- Quality Factors (ICRP 26) and Radiation Weighting Factors (ICRP 60) were developed to account for the effects of higher LET radiation types
- For neutrons this relationship is energy dependent!

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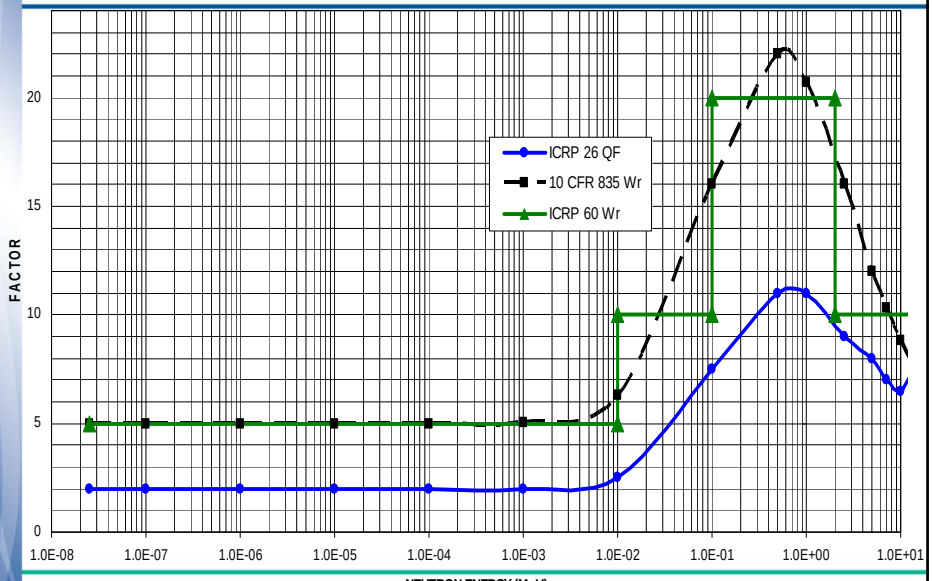
Comparison of ICRP 26 QF with ICRP 60 W_r



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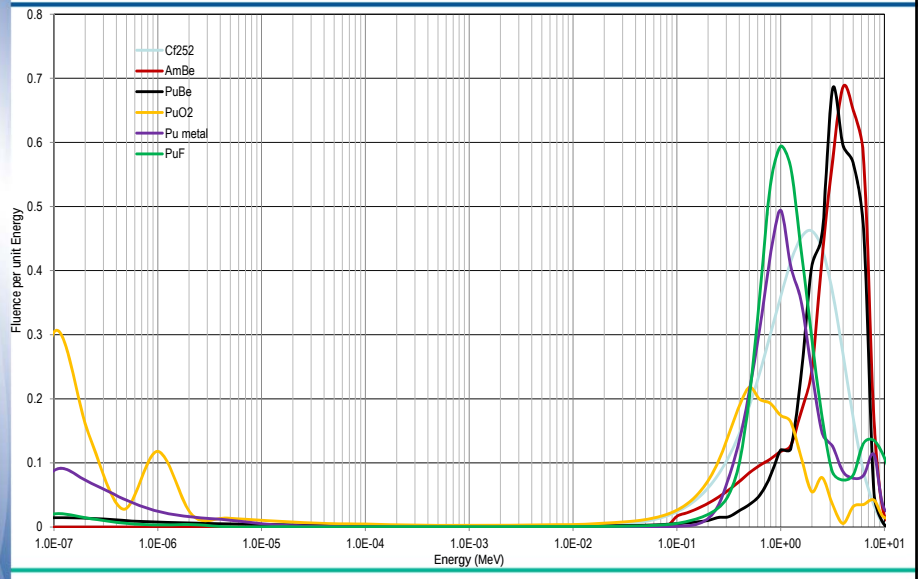
Various Neutron Spectra



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Personnel Monitoring

- Radiological workers with the potential for neutron exposure are issued a 912 Thermoluminescent Neutron Dosimeter
  - 4 $Li_2B_4O_7$ phosphors shielded in various configurations with cadmium and tin
    - 3 of the 4 phosphors are enriched ^6Li
  - Measures neutron exposure to personnel via the albedo effect
- We need to determine a factor that accounts for the entire neutron spectrum

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Rotating Neutron Spectrometer (ROSPEC)

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Rotating Neutron Spectrometer (ROSPEC)

- 6 gas filled proportional detectors affixed on a rotating platform

Counter Name	Diameter (Inches)	Fill Gas	Fill Gas Pressure (atm)	Energy Range (MeV)
Thermal	2	Helium	0.08	<1E-6
Epi-thermal	2	Helium	0.5	1E-6 – 1E-2
SP2-1	2	Hydrogen	0.75	0.05 - 0.25
SP2-4	2	Hydrogen	4	0.15 - 0.70
SP2-10	2	Hydrogen	10	0.40 - 1.50
SP6	6	P10	5	1.20 - 4.50

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Rotating Neutron Spectrometer (ROSPEC)

- Software compiles results from each detector to generate a neutron spectrum
- Measures neutron fluence for each energy bin and calculates H(max), H*(10), and Hp(10) using fluence to dose conversion factors.
- E(AP) is calculated with a separate program that uses the neutron spectra generated by the ROSPEC

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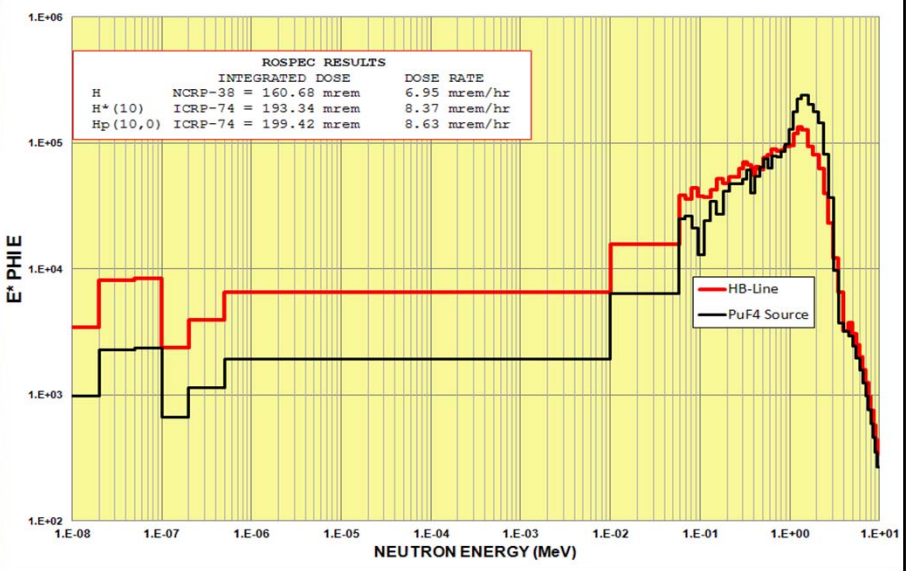
ROSPEC Neutron Spectrum



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Method

- Empirically measure neutron spectra with the ROSPEC in various neutron fields across the site

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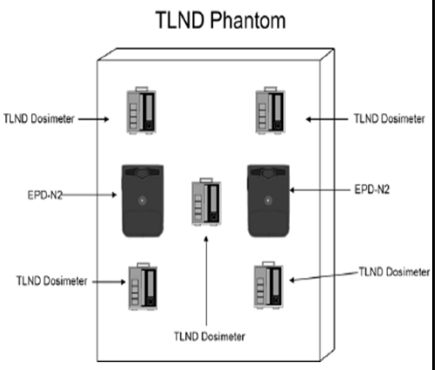
Method

- Setup a phantom with TLND's and EPD-N2's in the same location as the ROSPEC



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Method

- Measurements were performed in KAMS, H-Canyon, HB-Line, and E-Area
- Compare the TLND and EPD-N2 results with the personal dose equivalent calculated by the ROSPEC software
- The ratio of the personal dose equivalent, $H_p(10)$, and the average TLND response, $H^*(10)$, is equal to the neutron correction factor

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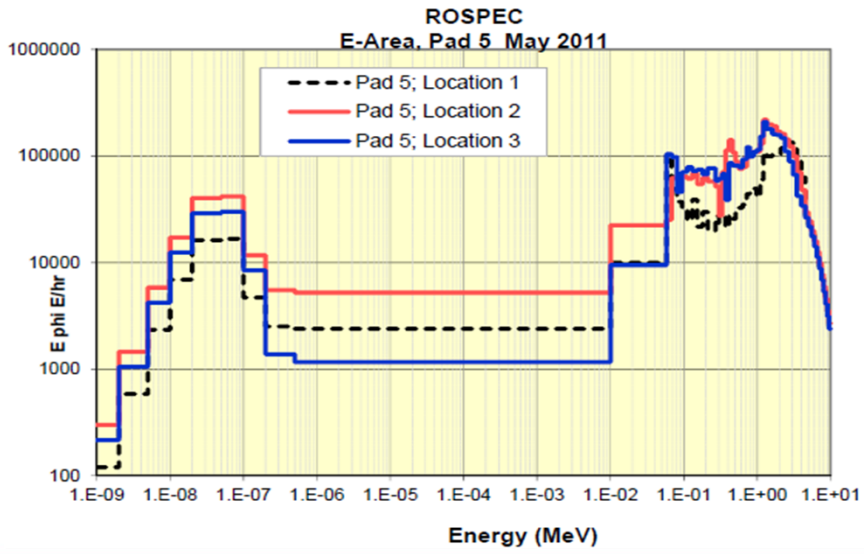
Measured Neutron Spectra



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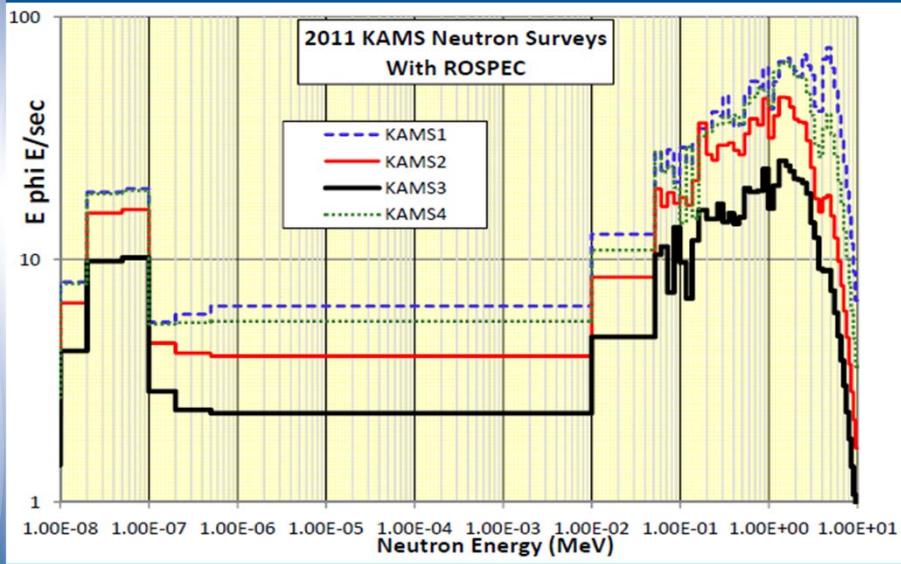
Measured Neutron Spectra



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Measurement Results

- Average facility correction factor is 2.36
  - For conservatism, a correction factor of 2.5 was implemented site wide
- ROSPEC/EPD-N2's ratio was 0.93
  - The response algorithm was adjusted to account for this difference

Location	Facility Correction Factor
E-Area Pad 5 – 1	3.48
E-Area Pad 5 – 2	1.91
E-Area Pad 5 – 3	3.11
E-Area Pad 5 – 4	2.68
E-Area Pad 5 – 5	1.43
E-Area Pad 15 – 1	2.04
E-Area Pad 15 – 2	3.35
H-Canyon	1.28
HB-Line	3.29
KAMS – 1	1.98
KAMS – 2	2.01
KAMS – 3	2.04
KAMS – 4	2.03

Conclusions

- Based on the measurement results, the neutron correction factor for the Savannah River Site is 2.5
- EPD-N2 response algorithms were adjusted
- Neutron spectral measurements should be performed anytime there is a change in the neutron source term or on a periodic basis to verify the neutron spectra